We claim:

1. An interferometer comprising:

a low coherence light source;

a first beam splitter in communication with the light source to split light from the light source into a first sample light beam to be directed onto a sample and a reference light beam, wherein a second sample light beam is received by the interferometer from the sample;

a diffraction grating positioned to diffract at least one of the reference light beam and the second sample light beam;

a second beam splitter positioned to receive the second sample light beam and the reference light beam, wherein at least one of the second sample light beam and the reference light beam has been diffracted by the diffraction grating, and the second sample light beam and the diffracted reference light beam are combined in the second beam splitter to form a combined light beam; and

a detector positioned to receive the combined light beam from the second beam splitter.

2. The interferometer of claim 1, wherein the diffraction grating is positioned to diffract the reference light beam and the second sample light beam is directed onto the second beam splitter without being diffracted.

3. The interferometer of claim 1, wherein the diffraction grating is a reflective diffraction grating, a transparent diffraction grating or an acousto optic modulator.

4. The interferometer of claim 1, wherein the detector is a multi-element photo detector.

5. The interferometer of claim 1, further comprising a signal processor electrically coupled to the detector to receive an output from the detector and to process the output.

6. The interferometer of claim 1, wherein the second beam splitter forms first and second combined light beams, the first combined light beam being received by the first detector, the interferometer further comprising:

a second detector positioned to detect the second combined light beam.

7. The interferometer of claim 6, further comprising first and second polarization filters positioned to filter the first and second combined light beams, respectively, with respect to first and second respective polarizations.

8. The interferometer of claim 6, wherein the first and second detectors are each multi-element detectors.

9. The interferometer of claim 1, wherein:

the first beam splitter is an approximately 50/50 beam splitter; and

the second beam splitter directs more than half of the light energy of the second sample light beam into the combined beam and directs less than half of the light energy of the reference light beam into the combined beam.

10. The interferometer of claim 9, wherein the second beam splitter directs substantially more than half of the light energy of the second sample light beam into the combined light beam and directs substantially less than half of the light energy of the reference light beam into the combined beam.

11. The interferometer of claim 10, wherein the second beam splitter directs at least about 90% of the light energy of the second sample light beam into the combined light beam and

directs about 10% or less of the light energy of the reference light beam into the combined light beam.

12. The interferometer of claim 1, wherein the first beam splitter directs more than half of the light energy received from the light source into the sample light beam and less than half of the light energy received from the light source into the reference light beam.

13. The interferometer of claim 12, further comprising an optical circulator, wherein the sample light beam is directed to the sample through the optical circulator and the second sample light beam is directed to the second beam splitter through the optical circulator.

14. The interferometer of claim 12, wherein the second beam splitter directs substantially more than half of the light energy received from the light source into the sample light beam and substantially less than half of the light energy received from the light source into the reference light beam.

15. The interferometer of claim 14, wherein the first beam splitter directs at least about 90% of the light energy received from the light source into the sample light beam and about 10% or less of the light energy received from the light source into the reference light beam.

16. An interferometer comprising:

a first low coherence light source and a second low coherence light source, each emitting light at a different wavelength;

a first beam splitter in communication with the first and second light sources to split the light from the light sources into a first sample light beam to be directed onto a sample and a reference light beam, wherein a second sample light beam is received by the interferometer from the sample;

a diffraction grating positioned to diffract at least one of the reference light beam and the second sample light beam;

a second beam splitter positioned to receive the reference light beam and the second sample light beam, wherein at least one of the reference light beam and the sample light beam has been diffracted by the diffraction grating, the second beam splitter forming two combined light beams;

a first detector positioned to receive one of the combined light beams; and

a second detector positioned to receive the other of the combined light beams.

17. The interferometer of claim 16, wherein the first detector detects light at the wavelength of the first light source and the second detector detects light at the wavelength of the second light source.

18. The interferometer of claim 16, wherein the first and second detectors are multi-element detectors.

19. The interferometer of claim 16, wherein one of the light sources emits light in a wavelength band that induces fluorescence in the sample.

20. The interferometer of claim 16, wherein:

the reference light beam is diffracted by the diffraction grating; and

the second sample light beam is directed onto the second beam splitter, undiffracted.

21. The interferometer of claim 16, wherein light is conveyed from the first and second light sources to the beam splitter by an optical fiber.

22. An interferometer comprising:

a low coherence light source;

a first, fiber optic beam splitter;

a first optical fiber optically coupling the light source to the first beam splitter, wherein the first beam splitter splits light received from the light source into a sample light beam and a reference light beam;

a second optical fiber to convey the sample light beam onto a sample and to convey a second sample light beam received from the sample to the first beam splitter;

a second beam splitter;

a third optical fiber optically coupling the first beam splitter to the second beam splitter to convey the second sample light beam, at least in part, from the first beam splitter to the second beam splitter;

a diffraction grating;

a fourth optical fiber optically coupling the first beam splitter to the diffraction grating to convey the reference light beam, at least in part, to the diffraction grating;

wherein the second beam splitter is positioned to receive the diffracted reference light beam and the reference light beam and the second sample light beam are combined in the second beam splitter to form a combined light beam; and

a detector positioned to receive the combined light beam.

23. The interferometer of claim 22, wherein:

the first beam splitter is an approximately 50/50 beam splitter; and

the second beam splitter directs more than half of the light energy received from the light source into the sample light beam and less than half of the light energy received from the light source into the reference light beam.

24. The interferometer of claim 22, further comprising:

a focusing lens to focus the sample light beam onto the sample and to focus the second sample light beam;

a first collimator optically coupled between the third optical fiber and the second beam splitter such that the third optical fiber conveys the second sample light beam to the first collimator to collimate the second sample light beam and the collimated sample light beam is directed to the second beam splitter;

a second collimator optically coupled between the fourth optical fiber and the diffraction grating such that the fourth optical fiber conveys the reference light beam to the second collimator to collimate the reference light beam and the collimated reference light beam is directed onto the diffraction grating; and

a conjugating lens between the second beam splitter and the detector.

25. The interferometer of claim 22, wherein the diffraction grating is a reflective diffraction grating, a transparent diffraction grating, or an acousto-optic modulator.

26. The interferometer of claim 22, wherein the second beam splitter directs substantially more than 50% of the light energy received from the light source into the sample light beam and substantially less than 50% of the light energy received from the light source into the reference light beam.

27. The interferometer of claim 26, wherein the second beam splitter directs at least about 90% of the light energy received from the light source into the sample light beam and about 10% or less of the light energy from the light source into the reference light beam.

28. The interferometer of claim 22, further comprising a catheter and an optical fiber within the catheter, wherein the second optical fiber is optically coupled to the optical fiber within the catheter.

29. The interferometer of claim 22, further comprising a phase modulator to modulate either of the reference light beam and the sample light beam.

30. The interferometer of claim 22, further comprising a signal processor electrically coupled to the detector to receive an output from the detector and to process the output.

31. The interferometer of claim 22, wherein the light source is pulsed.

32. The interferometer of claim 22, wherein the detector is a multi-element photo detector.

33. An interferometer comprising:

a low coherence light source;

a first fiber optic beam splitter;

a first optical fiber optically coupling the light source to the first beam splitter, wherein the first beam splitter splits light received from the light source into a sample light beam and a reference light beam;

an optical circulator having a first port, a second port and a third port, wherein light input to the first port exits the optical circulator from the second port and light entering the second port exits the optical circulator from the third port;

a second optical fiber optically coupling the first beam splitter to the first port of the optical circulator;

a third optical fiber to convey the sample light beam to a sample and to convey a second sample light beam received from the sample to the first beam splitter;

a second beam splitter;

a fourth optical fiber optically coupling the third port of the optical circulator to the second beam splitter, wherein the third optical fiber conveys the second sample light beam, at least in part, from the third port to the second beam splitter;

a diffraction grating;

a fifth optical fiber optically coupling the first beam splitter to the diffraction grating to convey the reference light beam, at least in part, to the diffraction grating;

the second beam splitter being positioned to receive the diffracted reference light beam from the diffraction grating, wherein the reference light beam and the second sample light beam combine in the beam splitter to form a combined light beam; and

a detector positioned to receive the combined beam

34. The interferometer of claim 33, wherein the light received from the light source has an energy and the first beam splitter splits the light into a sample light beam having more than half of the energy of the light and a reference light beam having less than half of the energy of the light.

35. The interferometer of claim 34, further comprising:

a focusing lens to focus the sample light beam onto the sample and to focus the second sample light beam;

a first collimator optically coupled between the fourth optical fiber and the second beam splitter such that the fourth optical fiber conveys the second sample light beam to the first collimator to collimate the second sample light beam and the collimated sample light beam is directed to the second beam splitter;

a second collimator optically coupled between the fifth optical fiber and the diffraction grating such that the fifth optical fiber conveys the reference light beam to the second

collimator to collimate the reference light beam and the collimated reference light beam is directed onto the diffraction grating; and

a conjugating lens between the second beam splitter and the detector.

36. The interferometer of claim 34, wherein the second beam splitter is an approximately 50/50 beam splitter and the second sample light beam and the reference light beam are combined in the second beam splitter to form first and second sample light beams, wherein the first combined light beam is received by the first detector; and

the interferometer further comprises a second detector positioned to receive a second combined light beam from the second beam splitter.

37. The interferometer of claim 34, further comprising first and second conjugating lens between the first detector and the second beam splitter and the second detector and the second beam splitter, respectively.

38. The interferometer of claim 36, wherein the first and second detectors are each a multi-element photo detector.

39. The interferometer of claim 36, further comprising first and second polarization filters positioned to filter the first and second combined light beams, respectively, with respect to first and second respective polarizations.

40. The interferometer of claim 36, further comprising:

a second light source optically coupled to the first optical fiber, the second light source emitting light at a wavelength different than the wavelength of the first light source;

wherein the first detector detects light at a wavelength corresponding to the wavelength of the light emitted by the first light source and the second detector detects light at a wavelength corresponding to the wavelength of the light emitted by the second light source.

41. The interferometer of claim 40, wherein one of the light sources emits light in a wavelength band that induces fluorescence in the sample.

42. The interferometer of claim 34, wherein the second beam splitter directs more than half of the energy in the second sample light beam into the combined beam and less than half of the energy in the reference light beam into the combined beam.

43. The interferometer of claim 34, further comprising a phase modulator to modulate either one of the reference light beam and the second sample light beam

44. The interferometer of claim 34, wherein the diffracting grating is a reflective diffraction grating, a transparent diffraction grating, or an acousto-optic modulator

45. The interferometer of claim 36, further comprising a catheter, wherein at least a portion of the third optical fiber is within the catheter.

46. The interferometer of claim 34, further comprising a catheter, wherein at least a portion of the third optical fiber is within the catheter.

47. The interferometer of claim 34, further comprising:

a signal processor electrically connected to the detector to receive an output from the detector and to process the signals.

48. The interferometer of claim 34, wherein the light source is pulsed.

49. The interferometer of claim 34, wherein the first beam splitter splits the light received from the light source into a sample light beam having substantially more than half of the energy of the light and a reference light beam having substantially less than half of the energy of the light.

50. The interferometer of claim 49, wherein the first beam splitter directs at least about 90% of the light energy received from the light source into the sample light beam and about 10% or less of the light energy received from the light source into the reference light beam.

51. The interferometer of claim 36, wherein the first beam splitter splits the light received from the light source into a sample light beam having substantially more than half of the energy of the light and a reference light beam having substantially less than half of the energy of the light.

52. The interferometer of claim 51, wherein the second beam splitter directs at least about 90% of the light energy received from the light source into the sample light beam and about 10% or less of the light energy received from the light source into the reference light beam.

53. An interferometer comprising:

a low coherence light source;

a first beam splitter in communication with the light source to split light from the light source into a sample light beam to be directed onto a sample and a reference light beam wherein a second light beam is received by the interferometer from the sample;

a second beam splitter for generating two combined light beams from the second sample light beam and the reference light beam, wherein an optical path difference has been introduced into at least one of the second sample light beam and the reference light beam;

first and second detectors, each positioned to receive one of the combined light beams;

first and second polarization filters, each filtering light with respect to a different polarization, the first polarizing filter being between the second beam splitter and the first

detector and the second polarizing filter being between the second beam splitter and the second detector.

54. The interferometer of claim 54, wherein each detector is a multi-element detector.

55. The interferometer of claim 54, further comprising a signal processor coupled to each detector to analyze the outputs of each detector.

56. The interferometer of claim 54, further comprising a diffraction grating to introduce the optical path difference to at least one of the second sample light beam and the reference light beam.

57. The interferometer of claim 56, wherein the diffraction grating introduces the optical path difference to the reference light beam.

58. A method of imaging a sample material comprising the steps of:

splitting a low coherence light beam into a sample light beam and a reference light beam;

directing the sample light beam onto a sample and receiving a second sample light beam from the sample;

diffracting one of the reference light beam and the second sample light beam;

after the diffracting step, combining the second sample light beam with the diffracted light beam by a beam splitter to form a combined light beam; and

detecting the combined light beam with a detector.

59. The method of claim 58, further comprising the steps of:

splitting the low coherence light beam by a first, approximately 50/50 beam splitter; and

combining the light received from the sample with the diffracted reference light beam by a second non 50/50 beam splitter.

60. The method of claim 59, further comprising the steps of:

conveying the low coherence light beam to a first beam splitter to split the light beam, by a first optical fiber;

conveying the sample light beam to a lens to focus the light beam onto the sample, by a second optical fiber;

conveying the light received from the sample back to the first beam splitter by the second optical fiber;

conveying the light received from the sample from the first beam splitter to a first collimator, by a third optical fiber;

conveying a collimated received light beam to the second beam splitter;

conveying the reference light beam from the first beam splitter to a second collimator by a fourth optical fiber; and

conveying a collimated reference light beam to a diffraction grating to diffract the collimated reference light beam.

61. The method of claim 59, further comprising the step of combining the light received from the sample with the diffracted reference light beam to form a combined light beam having substantially more than half of the light energy of the light received from the sample and substantially less than half of the light energy of the diffracted reference light beam.

62. The method of claim 61, comprising the step of combining the light received from the sample with the diffracted reference light beam to form a combined light beam having at

least about 90% of the light energy of the light received from the sample and about 10% or less of the light energy of the diffracted reference light beam.

63. The method of claim 59, wherein the sample is biological tissue.

64. A method of analyzing a sample material comprising the steps of:

splitting a low coherence light beam having an energy into a sample light beam having more than half of the energy of the light beam and a reference light beam having less than half of the energy of the light beam;

directing the sample light beam onto a sample;

diffracting the reference light beam;

combining the light received from the sample with the diffracted reference light beam to form a combined light beam; and

detecting the combined light beam with a detector.

65. The method of claim 64, further comprising the steps of:

splitting the light beam into the sample light beam and the reference light beam by a first non 50/50 beam splitter, wherein the light received from the sample bypasses the first beam splitter; and

combining the light received from the sample with the diffracted reference light beam by a second, approximately 50/50 beam splitter.

66. The method of claim 65, further comprising the steps of:

focusing the sample light beam onto the sample with a focusing lens;

conveying the sample light beam to the focusing lens through an optical circulator; and

conveying the light received from the sample to the second beam splitter for combination with the reference light beam through the optical circulator.

67. The method of claim 66, further comprising the steps of:

conveying the light beam to a first fiber optic beam splitter to split the light beam, by a first optical fiber;

conveying the sample light beam to an optical circulator by a second optical fiber;

conveying the sample light beam to a lens to focus the sample light beam onto the sample, by a third optical fiber;

conveying the light received from the sample back to the optical circulator by the third optical fiber;

conveying the received light from the optical circulator to a first collimator by a fourth optical fiber;

conveying a first collimated light beam from the first collimator to a second beam splitter;

conveying the reference light beam from the first beam splitter to a second collimator by a fifth optical fiber; and

conveying a second collimated reference light beam to the second beam splitter for combination with the first collimated light beam.

68. The method of claim 59, further comprising the steps of:

combining the received light and the reference light beam into two combined light beams; and

detecting each of the combined light beams.

69. The method of claim 68, comprising the step of splitting the light beam into a sample light beam having substantially more than half of the energy of the low coherence light beam and a reference light beam having substantially less than half of the energy of the low coherence light beam.

70. The method of claim 69, comprising the step of splitting the light beam into a sample light beam having at least about 90% of the energy of the low coherence light beam and a reference light beam having about 10% or less of the energy of the low coherence light beam.

71. The method of claim 64, further comprising the step of providing the low coherence light beam from a first light source emitting light at a first wavelength and a second light source emitting light at a second wavelength different than the first wavelength; and

detecting the first wavelength in one of the combined beams with a first detector and detecting the second wavelength in the other of the combined beams by a second detector.

72. The method of claim 71, further comprising the step of filtering one of the combined beams with respect to a first polarization and filtering the other of the combined beams with respect to a second polarization, prior to detecting the combined beams.

73. The method of claim 64, wherein the sample is biological tissue.